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EFFECT OF VARIOUS FORMS AND APPLICATION TIME OF MINERAL NITROGEN ON WHEAT PRODUCTIVITY IN THE NEWLY RECLAIMED LANDS .

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ABSTRACT

The best combination of forms and application time of chemical nitrogen fertilizer is considered one of the primary factors for high grain yield in wheat. The present investigation was designed to study the response of Giza 163 wheat cultivar to three forms and fourteen different times for application of nitrogen fertilizer in the newly reclaimed land conditions. Two field experiments were carried out in two consecutive winter seasons of 2001 / 2002 and 2002 / 2003 located at El-Bustan Experimental Farm, Faculty of Agriculture, Damanhour.

A split-plot design in a randomized complete block arrangment, with three replicates, was used. The three nitrogen forms (ammonium sulphate 20.5 % N, ammoninm nitrate 33.5 % N and urea 46 % N) were assigned to the main plots, whereas the fourteen times of applying the three formes [either adding one dose or equal splitting doses at different stages of growth(at sowing , 1st irrigation, tillering and at heading)] were allocated to the sub - plots .

The results revealed that nitrogen addition, as ammonium sulphate, had favorable effects in improving all studied traits, in the two seasons. Grain yield /ha was increased due to using N as ammonium sulphate, as compared with ammonium nitrate and urea, by 15.44 and 44.55 % as averaged over both seasons, respectively. Splitting nitrogen into four equall doses (at sowing, 1st irrigation, tillering or at heading) resulted in a significant increase for most of studied traits in both seasons.

A significant interactions were obtained between nitrogen forms and their times of application for all studied traits, except for straw yield and harvest index in both seasons.

Therefore, this study recommended wheat fertilization by using ammounium sulphate in four equal splits (at sowing, 1 st irrigation, tillering or at heading) under newly reclaimed lands .

INTRODUCTION

Increasing wheat production could be achieved through maximizing production per unit area and / or culturing deserts to expand the planted area. Maximizing production per unit area could be achieved via developing high yielding genotypes and simultaneously implementing proper cultural practices. The other way for narrowing the gap between Egyptian production and consumption is, growing wheat in the newly reclaimed areas, as indicated by Shehab El- Din (1993). Growing wheat in marginal lands requires specific cultural practices differing from those applied to the old planted fertile ones.

Nitrogen fertilization is among the most important factors in wheat management package. Newly reclaimed areas in Egypt, as well as in many parts of the world, are poor in nitrogen content. Hence, wheat prodution in

those areas is low and improved management practices are needed to increase production efficiency. Forms and times of chemical nitrogen fertilizer application, and the best combination of both, are the two basic important elements for high wheat grain yield production.

Among the available forms of nitrogenous fertilizers, ammonium sulphate, ammonium nitrate and urea are widely used in wheat production. Thus, the study of those fertilizers in the newly reclaimed land conditions, with regard to their effects on wheat productivity, is of great importance. In this respect, Alessi and Power (1972) and Khalifa (1973) reported that grain yield of wheat was not significantly affected by different N forms. Eid (1977) found that plant height and grain yield / fed. were significantly increased due to the addition of ammonium sulphate or ammonium nitrate, as compared with urea, and added that straw yield / fed. was siginificantly increased when N was applied as ammonium nitrate. Also, Christensen and Meints (1982) observed that wheat straw yield / ha. was higher when N was added as urea than as ammonium nitrate. Grain yield was not significantly affected by N forms of ammonium nitrate, urea and ammonium nitrate as reported by Lutcher and Mahler (1988).

Moselhy (1995), under desert conditions, found that addition of N as ammonium sulphate, followed by ammonium nitrate recorded the highest averages of each of plant height, number of spikes / m^2, spike length, number of spikelets / spike, number of grains / spike, 1000 – grain weight, straw yield and grain yield. Hassanein *et al.* (1997) revealed that the different sources of nitrogen fertilizer had no effect on straw yield. Hassan and Gaballah (2000) stated that nitrogen addition, as ammonium nitrate, under new reclaimed sandy soils showed a favourable significant effect in improving plant height, number of spikes / m^2, spike length, number of spikelets / spike, number of grains / spike , 1000 - grain weight , harvest index and grain yield, compared with urea .

Regarding splitting of N fertilizer application, several studies have reported the advantages of splitting N fertilizer in order to increase wheat grain yield and its components under sandy soil conditions (Abd El - Maaboud, 1991; Dawood, 1994; Moselhy, 1995; Abdul Galil *et al.*, 1997, El-Hosary *et al.* , 2000 and Mowafy, 2002)

The present study aimed to investigate the effect of three forms and fourteen times of application of chemical nitrogen fertilizers on Giza 163 wheat cultivar under newly reclaimed land conditions .

MATERIALS AND METHODS

Two field experiments were conducted in 2001 / 2002 and 2002 / 2003 winter seasons at El-Bustan Experimental Farm of Collage of Agriculture , Damanhour , Alexandria University ,Egypt .

The three nitrogen forms tested were ammonium sulphate (20.5%N), ammonium nitrate (33.5 % N) and urea (46 % N) were applied at the rate of 288 kgN /ha. The different fourteen times of application (as one dose or equally split doses at different stages of growth) are given in Table (1) .

Table 1 : Application time of nitrogen fertilizer .

No. of doses	Frequency and stage of application time .			
	at sowing	at 1st irrigntion *	at tillering	at heading
One	•	—	—	—
	—	•	—	—
	—	—	•	—
	—	—	—	•
Two	•	•	—	—
	•	—	•	—
	•	—	—	•
	—	•	•	—
	—	—	•	•
Three	•	•	•	—
	•	•	—	•
	—	•	•	•
	•	—	•	•
Four	•	•	•	•

* First irrigation was given 14 days after sowing.

A split - plot design in a randomized complete block arrangment, with three replicates, was followed in both seasons . The nitrogen forms were allocated to the main plots, whereas the fourteen times of N application were randomly assigned to the sub-plots. The sub–plot was 2×3m,including 10 rows ; 20 cm apart .

The soil of experimentation site was sandy. The mechanical and chemical analysis of the soil are given in Table (2).

Table 2: Some soil physical and chemical properties of experimental site .

Property	Season	
	2001 / 2002	2002 / 2003
Texture	Sandy	Sandy
pH	8.1	8.2
Available N(ppm)	90	84
Available P(ppm)	18	16
Available K(ppm)	130	133
Total nitrogen (%)	0.214	0.110
Organic matter (%)	0.60	0.65

Both phosphorus and potassium fertilizers were applied before sowing at the rate of 72 kgP_2 0_5 and 58 kg K_20 / ha., respectively. The recommended seeding rate of 144 kg / ha. was used. Irrigation and all other cultural practices were conducted as recommended for wheat production in the region. Harvested area was 2.4 m^2 (the four inner rows of each sub-plot). At milk ripe stage, flag leaf area was determined, using the method suggested by Lal and Subba Rao (1951). At harvest, the following traits were determined:

1. Plant height (cm)
2. Spike length (cm).
3. Number of spikes / m^2 .
4. Number of spikelets / spike.
5. Number of kernels / spike.
6. 1000 – kernel weight (g).
7. Grain yield (ton / ha) .
8. Straw yield(ton /ha).
9. Harvest index (%).

The data were statistically analyzed, according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Forms of Nitrogen Fertilizer Effect :-

Data in Table (3) indicated that most of the studied traits responded significatly to the application of nitrogen forms. Ammonium sulphate resulted in the highest means, followed by ammonium nitrate and urea (Tables 4,5,6,7,8,9,10,11and 12). These two nitrogen forms, also, gave higher means when applied either equally splited or in one dose, in comparison to urea form. The results in Table (11) showed that grain yield / ha. was increased by adding nitrogen application as ammonium sulphate compared to ammonium nitrate or urea by 15.44 and 44.55%., averaged over both seasons, respectively .In this concern , Singh *et al* (1992) and Abdul Galil *et al.* (1997) recorded the highest grain yield from application of nitrogen as ammonium sulphate. According to the present data, it could be concluded that ammonuim sulphae and ammonium nitrate were more efficient than urea. These results are in general agreement with those obtained by many investigators; i.e., Eid(1977), Lutcher and Mahler(1988), Moselhy (1995), Hassanein *et al.* (1997) and Hassan and Gaballah(2000). However, Nour *et al.* (1989), Sharshar (1989), Abd El-Zaher (1997) and Saleh(2001) they obtained the highest grain yield from application of nitrogen as urea compared with that obtained from the other nitrogen sources . On the other hand, Tiwari and Singh (1966), Singh and Gupta (1969), Khalifa (1973), Goos (1981), Hamissa *et al.* (1984) and Mahler *et al.* (1994) found that application of different nitrogen sources had the same effect on grain yield as no significant differences could be detected.

Abd EL-Zaher (1997) obtained the highest average of each of plant height, spike length, number of spikelets and grains / spike, 1000 – grain weight and number of spikes / m^2 from the use of urea, whereas Abdul Galil *et al.* (1997) got the highest average of those yield attributes from the use of ammonium sulphate. On the contrary, Sharshar (1989) and EL- Hefnawy *et al.* (1991) found no significant differences between nitrogen sources regarding 1000- grain weight.

It may be explained that wheat makes the maximum use of nitrogen in the ammonium than amide form due to easily nitrified form of ammonium rather than the amide forms of urea. The high efficiency of ammonium sulphate and ammonium nitrate, compared to urea, could be partly attributed to more volatilization of urea fertilizer which results in higher losses of N under alkaline soil conditions as reported by Alessi and Power (1972) and Hassan and Gaballah (2000). Since the soil pH of the experimental site showed high alkaline values, that might be one of the reasons for the lower efficiency of N applied in the urea form .

Table (3):Significance of mean squares for some plant traits, grain yield (t/ha.) and yield components for wheat as affected by different forms of nitrogen fertilizer and different times of its application in 2001/2002 and 2002/2003 seasons .

S .O.V.	d.f	Traits and season									
		Plant height (cm)		Flag leaf area (cm^2)		Spike length (cm)		Number of spikes/m^2		No . of spikelets/spike	
		2001/2002	2002/2003	2001/2002	2002/2003	2001/2002	2002/2003	2001/2002	2002/2003	2001/2002	2002/2003
Replications	2	*	*	**	**	**	*	**	**	**	**
Forms of nitrogen fertilizer (A)	2	*	*	**	NS	**	**	NS	NS	**	**
Error "a"	4	699.6	465.84	14.36	73.44	4.19	3.73	11238.32	12837.02	11.35	12.27
Times of nitrogen application (B)	13	**	**	**	**	**	**	**	**	**	**
B× A	26	*	*	**	**	**	**	**	**	**	**
Error "b"	78	126.66	326.76	4.85	4.81	1.04	1.47	1084.96	1658.24	1.26	1.14
C .V. %		11.78	17.10	7.47	6.41	6.56	7.14	10.32	12.80	5.41	4.93

*, **, Significant at 0.05 and 0.01 levels, respectively .
NS: Not significant .

Table (3):Cont.

S .O.V.	d.f	Traits and season									
		No . of kernels / spike		1000 - kernel weight (g.)		Grain yield (t / ha)		Straw yield (t / ha)		Harvest index (%)	
		2001/2002	2002/2003	2001/2002	2002/2003	2001/2002	2002/2003	2001/2002	2002/2003	2001/2002	2002/2003
Replications	2	**	*	NS	NS	**	**	*	*	*	*
Forms of nitrogen fertilizer (A)	2	**	**	NS	NS	**	**	NS	**	*	**
Error "a"	4	34.72	11.79	31.31	40.21	1.61	1.30	11.96	3.28	19.28	21.26
Times of nitrogen application (B)	13	**	**	**	*	**	**	NS	NS	*	*
A ×B	26	**	**	**	**	*	*	NS	NS	NS	NS
Error "b"	78	11.23	8.13	12.64	4.20	0.37	0.39	2.36	2.61	2.26	1.95
C .V %		8.20	6.67	9.15	5.21	12.29	12.20	13.32	14.52	5.00	4.45

*, **, Significant at 0.05 and 0.01 levels, respectively .
NS: Not significant .

Table 4 : *Means of plant height (cm) for wheat as affected by the interaction between three forms of nitrogen fertilizer (A) and fourteen times of its application (B) in 2001 / 2002 and 2002 / 2003seasons .*

Times of nitrogen applicattion (B)				2001 / 2002				2002 / 2003			
				Forms of N - fertilizer(A)				Forms of N - fertilizer (A)			
at sowing	at 1st irrigation	at tillering	at heading	Ammonium sulphate	Ammonium nitrate	Urea	Mean	Ammonium sulphate	Ammonium nitrate	Urea	Mean
One dose :											
•	—	—	—	102.0	71.50	70.40	81.30	126.50	86.40	70.60	94.50
—	•	—	—	83.50	94.30	77.50	85.10	121.40	97.30	70.20	96.30
—	—	•	—	109.0	96.20	86.40	97.20	100.70	99.60	94.30	98.20
—	—	—	•	77.6	70.70	62.30	70.20	81.60	88.10	91.60	87.10
mean				93.03	83.18	74.15	83.45	107.55	92.85	81.68	94.03
Two splitting doses :											
•	•	—	—	129.80	91.60	75.90	99.10	133.80	113.20	80.60	109.20
•	—	•	—	103.60	89.70	80.30	91.20	107.20	105.60	109.10	107.30
•	—	—	•	89.80	80.10	83.30	84.40	124.20	102.10	86.30	104.20
—	•	•	—	94.50	89.90	86.20	90.20	112.80	117.10	85.40	105.10
—	—	•	•	81.60	67.80	60.90	70.10	104.60	88.10	113.60	102.10
mean				99.86	83.82	77.32	87.00	116.52	105.22	95.00	105.58
Three splitting doses :											
•	•	•	—	137.60	98.20	83.40	106.40	125.63	115.20	93.40	111.41
•	•	—	•	107.80	93.40	93.10	98.10	126.00	114.50	99.10	113.20
—	•	•	•	142.10	123.20	110.3	125.2	89.00	112.60	123.30	108.30
•	—	•	•	119.40	112.60	105.20	112.40	119.10	118.03	109.40	115.51
mean				126.73	106.85	98.00	110.53	114.93	115.08	106.30	112.11
Four splitting doses :											
•	•	•	•	135.50	125.4	118.30	126.40	132.50	129.4	120.60	127.50
Grand mean				108.13	93.19	85.25	95.52	114.65	106.23	96.25	105.71
L.S.D 0.05											
A				16.05				13.09			
B				10.56				16.96			
AB				18.29				29.37			

Table 5 : Means of flag leaf area (cm^2) for wheat as affected by the interaction between three forms of nitrogen fertilizer (A) and fourteen times of its application(B) in 2001/2002 and 2002/2003 seasons.

Times of nitrogen applicattion (B)				2001 / 2002				2002 / 2003			
				Forms of N - fertilzer(A)				Forms of N - fertilizer (A)			
at sowing	at 1st irrigotion	at tillering	at heading	Ammonium sulphate	Ammonium nitrate	Urea	Mean	Ammonium sulphate	Ammonium nitrate	Urea	Mean
One dose :											
•	—	—	—	26.60	25.80	22.60	25.00	35.60	29.20	27.30	30.70
—	•	—	—	27.40	26.20	24.10	25.90	35.70	29.60	30.40	31.90
—	—	•	—	31.90	26.10	23.30	27.10	29.20	32.10	35.0	32.10
—	—	—	•	26.10	25.10	20.20	23.80	30.40	28.30	27.70	28.80
			mean	28.00	25.80	22.55	25.45	32.73	29.80	30.10	30.88
Two splitting doses :											
•	•	—	—	35.60	26.10	24.40	28.70	35.70	34.20	32.10	34.00
•	—	•	—	35.70	28.60	28.10	30.80	39.70	33.60	32.30	35.20
•	—	—	•	32.70	23.40	24.30	26.80	33.40	30.20	32.10	31.90
—	•	•	—	32.60	26.30	25.10	28.00	35.90	33.60	30.40	33.30
—	—	•	•	30.20	24.80	22.10	25.70	34.50	28.70	30.10	31.10
			mean	33.36	25.84	24.80	28.00	35.84	32.06	31.40	33.10
Three splitting doses :											
•	•	•	—	34.60	34.10	30.30	33.00	39.20	39.10	36.30	38.20
•	•	—	•	36.00	33.90	32.10	34.00	42.10	38.10	37.40	39.20
—	•	•	•	31.50	32.30	33.10	32.30	33.00	30.00	30.30	31.10
•	—	•	•	39.50	33.63	32.50	35.20	42.60	39.60	38.40	40.20
			mean	35.40	33.48	32.00	33.63	39.23	36.70	35.60	37.18
Four splitting doses :											
•	•	•	•	39.90	36.00	34.20	36.70	46.40	40.10	38.30	41.60
Grand mean				32.88	28.74	26.89	29.50	36.67a	33.31a	32.72a	34.24(1)
L.S.D 0.05											
A				2.30				NS			
B				2.07				2.06			
AB				3.58				3.56			

(1) Means followed by the same letter , are not significantly different, according to L.S.D.(0.05).

Table 6 : *Means of spike length (cm), for wheat as affected by the interaction between three forms of nitrogen fertilizer (A) and fourteen times of its application (B) in 2001 / 2002 and 2002 / 2003 seasons.*

Times of nitrogen applicattion (B)				2001 / 2002				2002 / 2003			
				Forms of N - fertilzer(A)				Forms of N - fertilizer (A)			
at sowing	at 1st irrigation	at tillering	at heading	Ammonium sulphate	Ammonium nitrate	Urea	Mean	Ammonium sulphate	Ammonium nitrate	Urea	Mean
One dose :											
•	—	—	—	16.3	12.8	10.50	13.20	16.1	13.30	14.7	14.70
—	•	—	—	16.9	13.6	11.50	14.00	17.3	13.20	14.2	14.90
—	—	•	—	16.5	13.1	13.3	14.30	17.4	15.9	13.5	15.60
—	—	—	•	16.3	12.2	9.8	12.77	15.1	14.2	10.3	13.20
				16.5	12.93	11.28	13.57	16.48	14.15	13.18	14.60
Two splitting doses :											
•	•	—	—	17.3	14.1	13.9	15.10	17.9	15.7	15.0	16.20
•	—	•	—	17.5	14.8	15.4	15.90	17.4	16.8	15.3	16.50
•	—	—	•	15.2	12.6	14.2	14.0	16.6	16.3	15.7	16.20
—	•	•	—	16.4	14.1	14.5	15.0	19.1	17.1	16.1	17.43
—	—	•	•	15.3	12.8	13.6	13.9	16.1	13.3	15.0	14.80
			mean	16.34	13.68	14.32	14.78	17.42	15.84	15.42	16.23
Three splitting doses :											
•	•	•	—	19.1	16.1	16.7	17.3	20.4	19.1	20.3	19.93
•	•	—	•	20.2	16.5	17.6	18.1	21.5	19.0	17.9	19.47
—	•	•	•	19.5	16.2	15.3	17.0	19.9	18.7	16.6	18.40
•	—	•	•	20.3	17.0	17.0	18.1	21.9	19.8	17.1	19.60
			mean	19.78	16.45	16.65	17.63	20.93	19.15	17.98	19.35
Four splitting doses :											
•	•	•	•	21.6	17.8	17.6	19.00	22.2	20.4	20.1	20.90
Grand mean				17.74	14.55	14.35	15.55	18.49	16.63	15.84	16.99
L.S.D 0.05											
A				1.24				1.17			
B				0.96				1.14			
AB				1.66				1.97			

Table 7 : Means of number of spikes / m^2 , for wheat as affected by the interaction between three forms of nitrogen fertilizer (A) and fourteen times of its application (B) in 2001 / 2002 and 2002 / 2003 seasons.

Times of nitrogen applicattion (B)				2001 / 2002				2002 / 2003			
				Forms of N- fertilizer (A)				Forms of N- fertilizer (A)			
at sowing	at 1st irrigation	at tillering	at heading	Ammonium sulphate	Ammonium nitrate	Urea	Mean	Ammonium sulphate	Ammonium nitrate	Urea	Mean
One dose :											
•	—	—	—	269.4	244.5	353.1	289.00	295.4	258.1	254.7	269.4
—	•	—	—	304.1	285.6	291.3	293.67	260.6	267.4	322.5	283.5
—	—	•	—	327.1	308.1	276.8	304.0	290.1	284.1	308.4	294.2
—	—	—	•	279.2	256.1	298.2	277.83	289.1	267.4	274.8	277.1
mean				294.95	273.58	304.85	291.13	283.8	269.25	290.10	281.05
Two splitting doses :											
•	•	—	—	355.0	333.1	273.1	320.4	370.1	326.2	302.6	332.97
•	—	•	—	329.2	332.6	313.5	325.1	340.4	333.3	313.3	329.00
•	—	—	•	339.6	312.1	282.5	311.4	330.1	255.1	295.1	293.43
—	•	•	—	337.2	320.4	282.0	313.2	359.2	281.7	241.7	294.20
—	—	•	•	315.2	312.6	288.4	305.4	320.2	248.9	248.9	272.67
mean				335.24	322.16	287.9	315.10	344.00	289.04	280.32	304.45
Three splitting doses :											
•	•	•	—	369.1	345.2	306.3	340.2	385.2	355.1	311.3	317.20
•	•	—	•	369.2	367.8	296.8	344.6	388.0	369.2	350.1	369.1
—	•	•	•	347.2	335.4	320.6	334.4	360.0	365.1	330.1	351.73
•	—	•	•	365.6	365.2	320.4	350.4	408.0	375.6	290.6	358.07
mean				365.28	353.40	308.53	342.4	380.3	366.25	300.53	349.03
Four splitting doses :											
•	•	•	•	409.7	381.3	291.1	360.7	397.2	408.7	433.4	413.1
Grand mean				336.91(1) a	321.43 a	299.58 a	319.31	342.40 a	313.99 a	298.40a	318.26
L.S.D 0.05											
A				NS				NS			
B				30.90				38.20			
AB				53.52				66.17			

(1) Means followed by the same letter , for each season ,are not significantly different ,according to L.S.D.(0.05) .

Table 8 : Means number of spikelets / spike, for wheat as affected by the interaction between three forms of nitrogen fertilizer (A) and fourteen times of its application (B) in 2001 / 2002 / and 2002 / 2003 seasons.

Times of nitrogen applicattion (B)				2001 / 2002				2002 / 2003			
				Forms of N-fertilizer (A)				Forms of N- fertilizer (A)			
at sowing	at 1st irrigotion	at tillering	at heading	Ammonium sulphate	Ammonium nitrate	Urea	Mean	Ammonium sulphate	Ammonium nitrate	Urea	Mean
One dose :											
•	—	—	—	18.1	14.4	12.5	15.0	14.8	11.9	11.7	12.8
—	•	—	—	19.2	16.6	16.6	17.47	18.2	17.1	13.0	16.1
—	—	•	—	21.1	18.5	15.9	18.5	20.2	18.1	15.7	18.0
—	—	—	•	16.2	14.1	12.3	14.2	13.3	10.8	9.50	11.2
mean				18.65	15.90	14.33	16.29	16.63	14.48	12.48	14.53
Two splitting doses :											
•	•	—	—	23.1	19.2	19.8	20.7	25.2	22.9	20.9	23.0
•	—	•	—	24.2	20.1	20.8	21.7	28.1	22.6	21.3	24.0
•	—	—	•	23.6	18.2	16.4	19.4	23.1	21.0	16.2	20.1
—	•	•	—	23.1	20.3	16.3	19.9	24.0	22.0	17.0	21.0
—	—	•	•	23.4	18.0	17.5	19.63	21.0	20.6	15.7	19.1
mean				23.48	19.16	18.16	20.27	24.28	21.82	18.22	21.44
Three splitting doses :											
•	•	•	—	24.1	22.1	21.6	22.6	27.6	25.8	24.9	26.1
•	•	—	•	27.2	22.6	21.2	23.67	29.3	26.1	25.9	27.1
—	•	•	•	24.2	21.1	21.3	22.2	29.4	24.0	21.6	25.0
•	—	•	•	28.3	23.5	22.6	24.8	30.2	27.1	26.7	28.0
mean				25.95	22.33	21.68	23.32	29.13	25.75	24.78	26.55
Four splitting doses :											
•	•	•	•	33.0	30.0	28.8	30.6	35.5	31.8	28.2	31.83
Grand mean				23.49	19.91	18.83	20.74	24.28	21.56	19.16	21.67
L.S.D 0.05											
A				2.04				2.12			
B				1.05				1.00			
AB				1.82				1.73			

Table 9 : Means number of kernels / spike, for wheat as affected by the interaction between three forms of nitrogen fertilizer (A) and fourteen times of its application (B) in 2001 / 2002 and 2002 / 2003 seasons.

Times of nitrogen application (B)				2001 / 2002				2002 / 2003			
				Forms of N- fertilizer (A)				Forms of N- fertilizer (A)			
at sowing	at 1st irrigation	at tillering	at heading	Ammonium sulphate	Ammonium nitrate	Urea	Mean	Ammonium sulphate	Ammonium nitrate	Urea	Mean
One dose :											
•	—	—	—	42.2	34.1	29.6	35.3	38.2	40.2	29.6	36.00
—	•	—	—	39.6	35.2	33.3	36.03	43.6	35.6	32.2	37.13
—	—	•	—	41.0	38.1	31.2	36.77	43.3	37.1	32.1	37.5
—	—	—	•	39.5	35.5	32.1	35.70	39.9	38.4	30.1	36.13
mean				40.58	35.73	31.55	35.95	41.25	37.83	31.0	36.69
Two splitting doses :											
•	•	—	—	47.6	37.4	32.9	39.30	44.5	42.1	40.1	42.23
•	—	•	—	48.2	38.1	35.1	40.47	49.3	43.2	39.2	43.90
•	—	—	•	43.1	38.5	40.4	40.67	46.2	42.1	38.1	42.13
—	•	•	—	47.0	37.1	40.1	41.40	48.1	44.7	35.4	42.73
—	—	•	•	45.1	44.6	33.2	40.97	47.2	40.1	38.1	41.80
mean				46.2	39.14	36.34	40.56	47.06	42.44	38.18	42.56
Three splitting doses :											
•	•	•	—	51.3	42.1	36.1	43.17	51.1	43.3	44.2	46.20
•	•	—	•	46.1	43.2	42.3	43.87	50.1	45.1	43.2	46.13
—	•	•	•	50.5	45.1	36.1	43.90	54.3	45.4	41.6	47.10
•	—	•	•	46.9	46.0	42.9	45.27	52.6	44.2	44.2	47.00
mean				49.45	44.1	38.6	44.05	52.03	44.50	43.3	46.61
Four splitting doses :											
•	•	•	•	58.7	49.2	40.1	49.33	62.8	47.9	46.7	52.47
Grand mean				46.20	40.30	36.10	40.87	47.94	42.10	38.20	42.75
$L.S.D_{0.05}$											
A				3.57				2.08			
B				3.14				2.67			
AB				5.44				4.63			

Table 10 : *Means of 1000 - kernel weight (g) , for wheat as affected bythe interaction between three forms of nitrogen fertilizer (A) and fourteen times of its application (B) in 2001 / 2002 and 2002 / 2003 seasons .*

Times of nitrogen applicattion (B)				2001 / 2002				2002 / 2003			
				Forms of N – fertilizer (A)				Forms of N - fertilizer (A)			
at sowing	at 1st irrigotion	at tillering	at heading	Ammonium sulphate	Ammonium nitrate	Urea	Mean	Ammonium sulphate	Ammonium nitrate	Urea	Mean
One dose :											
•	—	—	—	40.90	37.80	34.40	37.70	41.40	38.10	34.80	38.10
—	•	—	—	35.40	38.30	40.90	38.20	36.00	38.20	41.00	38.40
—	—	•	—	39.50	41.80	44.40	41.90	39.40	41.60	35.70	38.90
—	—	—	•	37.70	33.60	30.10	33.8	38.10	34.90	40.40	37.80
			mean	38.38	37.88	37.45	37.90	38.73	38.20	37.98	38.30
Two splitting doses :											
•	•	—	—	36.50	42.00	38.80	39.10	40.30	42.20	36.00	39.50
•	—	•	—	40.10	36.20	41.90	39.40	40.70	37.00	42.90	40.20
•	—	—	•	42.10	38.90	35.10	38.70	42.30	36.00	38.70	39.00
—	•	•	—	41.00	43.10	36.80	40.30	35.20	43.00	38.50	38.90
—	—	•	•	37.70	32.90	38.90	36.50	40.00	39.30	38.90	39.40
			mean	39.48	38.62	38.30	38.80	39.70	39.50	39.00	39.40
Three splitting doses :											
•	•	•	—	42.80	39.60	36.10	39.50	40.10	36.90	42.70	39.90
•	•	—	•	36.80	40.20	42.40	39.80	40.40	42.10	36.00	39.50
—	•	•	•	41.20	44.30	37.80	41.10	37.20	39.30	42.30	39.60
•	—	•	•	35.30	37.90	40.80	38.00	41.40	40.40	40.00	40.60
			mean	39.03	40.50	39.28	39.60	40.53	39.68	39.50	39.90
Four splitting doses :											
•	•	•	•	43.03	37.14	39.74	40.06	44.70	41.30	37.90	41.30
Grand mean				39.31(1) a	38.84 a	38.44 a	38.86	39.80 a	39.31 a	38.99 a	39.36
L.S.D 0.05											
A				NS				NS			
B				3.34				1.92			
AB				5.78				3.33			

(1) Means followed by the same letter , for each season ,are not significantly different,according to L.S.D.(0.05) .

Table 11 : *Means of grain yield (t / ha) for wheat as affected by the interaction between three forms of nitrogen fertilizer (A) and fourteen times of its application (B) in 2001 / 2002 and 2002 / 2003 seasons.*

Times of nitrogen applicattion (B)				2001 / 2002				2002 / 2003			
				Forms of N- fertilizer (A)				Forms of N- fertilizer (A)			
at sowing	at 1st irrigotion	at tillering	at heading	Ammonium sulphate	Ammonium nitrate	Urea	Mean	Ammonium sulphate	Ammonium nitrate	Urea	Mean
One dose :											
•	—	—	—	5.70	4.56	3.24	4.50	5.78	5.22	3.08	4.69
—	•	—	—	5.58	4.48	4.25	4.77	5.42	4.54	4.74	4.90
—	—	•	—	6.26	5.44	3.78	5.16	5.84	4.62	4.36	4.94
—	—	—	•	4.54	4.62	4.55	4.57	5.32	4.90	3.46	4.56
mean				5.52	4.78	3.96	4.75	5.59	4.82	3.91	4.77
Two splitting doses :											
•	•	—	—	5.00	5.17	3.78	4.65	6.11	5.02	3.66	4.93
•	—	•	—	5.80	5.34	3.56	4.90	6.03	4.54	4.82	5.13
•	—	—	•	5.72	4.39	5.50	4.87	6.13	5.70	3.26	5.03
—	•	•	—	5.98	5.23	4.12	5.11	6.00	5.76	3.72	5.16
—	—	•	•	5.68	4.75	3.52	4.65	5.48	4.23	4.54	4.75
mean				5.64	4.98	3.90	4.84	5.95	5.05	4.00	5.00
Three splitting doses :											
•	•	•	—	4.87	5.12	3.54	4.51	6.24	5.34	4.32	5.30
•	•	—	•	6.04	4.99	3.76	4.93	6.10	5.10	4.61	5.27
—	•	•	•	6.16	6.27	4.58	5.67	6.92	5.64	4.00	5.52
•	—	•	•	5.88	5.18	4.42	5.16	6.18	5.42	4.57	5.39
mean				5.74	5.39	4.08	5.07	6.36	5.38	4.38	5.37
Four splitting doses :											
•	•	•	•	7.40	5.54	4.62	5.85	7.15	6.05	4.94	6.05
Grand mean				5.76	5.08	4.02	4.95	6.05	5.15	4.15	5.12
L.S.D 0.05											
A				0.77				0.69			
B				0.57				0.59			
AB				0.99				1.01			

Table 12 : *Means of straw yield (t/ha) and harvest index (%) for wheat as affected by three forms of nitrogen fertilizer (A) and fourteen times of its application (B) in 2001 / 2002 and 2002 / 2003 seasons .*

Main effects	Straw yield (t/ha)			Harvest index (%)		
	2001/2002	2001/2002	combined	2001/2002	2001/2002	combined
Forms of N- fertilizer (A)						
Ammonium sulphate	12.6	12.50 a(1)	12.55	28.14 b	27.90 c	28.026
Ammonium nitrate	11.2	11.0 ab	11.10	29.90 ab	31.50 b	30.70 ab
Urea	10.79	9.89 b	10.34	32.14 a	34.83 a	33.49 a
F-test	Ns	**	Ns	*	**	*
Times f N- fertilizer application (B)						
One dose						
• — — —	11.79	11.56	11.68	28.5	29.3	28.90
— • — —	11.96	11.35	11.66	28.7	29.4	29.05
— — • —	11.85	11.53	11.69	28.9	29.5	29.20
— — — •	11.95	11.30	11.63	28.1	29.2	28.65
mean	11.89	11.44	11.67	28.55	29.35	28.95
Two splitting doses :						
• • — —	11.63	11.29	11.46	29.0	30.4	29.70
• — • —	11.78	10.90	11.34	29.8	32.0	30.90
• — — •	11.88	11.09	11.49	29.5	31.20	30.35
— • • —	11.63	10.77	11.20	30.1	32.4	31.25
— — • •	11.94	11.29	11.62	29.3	30.9	30.10
mean	11.77	11.07	11.42	29.54	31.38	30.46
Three splitting doses :						
• • • —	10.04	10.91	10.48	31.0	32.7	31.85
• • — •	11.16	10.65	10.91	31.9	33.1	32.50
— • • •	11.36	11.01	11.19	32.1	33.4	32.75
• — • •	11.17	10.99	11.08	31.6	32.9	32.25
mean	10.93	10.89	10.91	31.65	33.03	32.34
Four splitting doses :						
• • • •	11.25	11.21	11.23	32.4	33.4	32.90
F-test	Ns	Ns	Ns	*	*	**
Grand mean	11.53	11.13	11.33	30.06	31.41	30.74

(1) Means followed by the same letter(s), within each column , are not significantly different, according to L.S.D.(0.05).

Times of Nitrogen Application Effect :

Data of studied plant traits, grain yield and its components as affected by times of naitrogen application treatments in 2001/2002 and 2002/2003 seasons are presented in Tables (3,4,5,6,7,8,9,10,11 and 12). Data indicated that all studied traits, except for straw yields, were highly significantly affected by times of nitrogen application in both studied seasons(Table 3) .The results obtained in this investigation suggested that split applications of nitrogen fertilizer were likely to produce higher means of plant height , flag leaf area , spike length , number of spikelets / spike ,number of kernels / spike, 1000- kernel weight grain yield and harvest index than when the application was made in one single dose . The highest means of those traits were obtained when nitrogen fertilizer was splitted into equal four applications, supplied at sowing, 1st irrigation, tillering and at heading times. On the contrary, means of straw yield decreased when the application was splitted as compared with the application in one single dose (Table 12). Means of all studied traits tended to decrease when the whole amount of N was applied at sowing, 1st irrigation or at heading stage, as compared to application at tillering stage.

Interaction Effect:

As shown in Table (3), the statistical analysis indicated either significant or highly significant variations due to the interaction effect between forms of nitrogen fertilizer and their times of application.

The highest mean values for plant height were obtained by using ammonium suplhate added in three or four equal doses, in addition to application of ammonium nitrate and urea in four equal doses (Table 4).

Concerning flag leaf area, the highest mean values were obtained by splitting nitrogen to four equal dosses under the three forms of nitrogen; i.e., ammonium sulphate, ammonium nitrate and urea (Table 5). However, N in the ammonium sulphate form resulted in significantly remarkable values of flag leaf area than in the two other forms.

For spike length, the highest mean values were recorded by splitting N to four equal doses as ammonium sulphate form, with significant differenes over the two other forms of N; i.e., ammonium nitrate and urea, in the first and second seasons (Table 6).

For number of spikes /m^2, the highest mean values were recorded by ammonium sulphate form of nitrogen fentilizer when splitted into four doses, but was insignificantly different from ammonium nitrate form of nitrogen fertilizer when splitted into four doses and ammonium sulphate form of nitrogen fertilizer splitted into three doses (Table 7).

With respect to the number of spikelets / spike, data in Table (8) showed that the highest mean values resulted from fertilizing with nitrogen in ammonium sulphate form with splitting the amount into four equal doses, while the lowest values were obtained from plants fertilized with urea added as one dose at sowing .

The highest number of kernels per spike (58.7 and 62.8) was obtained from application of ammonium sulphate nitrogen form splitted into four equal doses , whereas the lowest values resulted from using urea

fertilizer in one dose at heading and at sowing stages in the first (29.6 and 32.1 kernels / spike) and second (29.6 and 30.1 kernels / spike) seasons , respectively (Table 9) .

Adding nitrogen in the form of ammonium sulphate as a four- split dose resulted in the highest value for 1000 - kernel weight (43.8 g as an average of both seasans). Meanwhile, application of nitrogen in urea form at one dose caused the lowest mean (37.72 g) over both seasons (Table 10).

Splitting ammonium sulphate as nitrogen fertilizer into four equal doses resulted in the highest mean of grain yield (7.27 t/ha) over two seasons. The superiority of ammonium sulphate nitrogen form in grain yield at four- split doses might be ascribed to the increase in the studied components of grain yield. Morever, applying urea in one dose gave the lowest mean (3.93 t/ha) over both seasons (Table 11) .

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تأثير إضافة صور مختلفة من السماد النيتروجيني المعدني في توقيتات متباينة علي إنتاجية القمح في الأراضي حديثة الاستصلاح ٠

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تعتبر صور الأسمدة النيتروجينية المعدنية وتوقيت إضافتها من أهم العوامل الأساسية التي تؤثر علي إنتاجية محصول الحبوب في القمح ٠ ومن ثم فقد صُمم هذا البحث لدراسة استجابة صنف القمح " جيزة ١٦٣ " لثلاث صور كيميائية من السماد النيتروجيني المعدني تمت إضافتها في أربعة عشر توقيتاً مختلفاً وذلك علي بعض الصفات النباتية ومحصول الحبوب ومكوناته ، ولذا فقد نفذت تجربتان حقليتان خلال موسمي شتاء ٢٠٠١/٢٠٠٢ , ٢٠٠٢/٢٠٠٣ ــ بمحطة البحوث الزراعية بالبستان ــ كلية الزراعة فرع دمنهور ٠ باستخدام تصميم القطع المنشقة مرة واحدة بثلاث مكررات ، حيث وزعت صور السماد النيتروجيني (سلفات النشادر ٢٠,٥ % أزوت ، نترات الأمونيوم ٣٣,٥ % أزوت ، اليوريا ٤٦% أزوت) عشوائيا في القطع الرئيسية بينما خُصصت القطع الفرعية لمواعيد إضافة هذه الأسمدة والتي تمثلت في إضافة كل صورة من السماد المعدني دفعة واحدة أو مقسمه إلي دفعات متساوية (عند الزراعة ، عند الرية الأولي ، عند التفريع ، عند طرد السنابل) ٠

وقد أوضحت نتائج هذه الدراسة أن إضافة السماد النيتروجيني المعدني في صورة سلفات نشادر أدت إلي حدوث زيادة في متوسطات الصفات التي تمت دراستها في كلا الموسمين ، حيث زاد متوسط محصول الحبوب بنسبة ١٥,٤٤ ، ٤٤,٥٥ % نتيجة التسميد بسماد سلفات النشادر مقارنة باستخدام نترات النشادر واليوريا علي التوالي (كمتوسط للموسمين) ٠

أدي تقسيم السماد النيتروجيني المعدني إلي أربع دفعات متساوية (عند الزراعة و عند الرية الأولي وعند التفريع وعند طرد السنابل) إلي زيادة معنوية في معظم الصفات التي تمت دراستها في كلا موسمي الدراسة فيما عدا محصول القش حيث نقص نتيجة تقسيم السماد ٠كما أظهرت النتائج وجود تفاعل معنوي أو عالي المعنوية بين صور السماد الأزوتي وتوقيت إضافته علي كل الصفات التي تمت دراستها باستثناء صفتي محصول القش ومعامل الحصاد في كلا الموسمين ٠

ومن نتائج هذه الدراسة يمكن التوصية بضرورة إستخدام السماد النيتروجيني المعدني المصنع في صورة سلفات النشادر (٢٠,٥ % أزوت) مع إضافته مقسما إلي أربع دفعات متساوية (عند الزراعة و عند الرية الأولي و عند التفريع و عند طرد السنابل) للحصول علي أفضل إنتاجية في حالة زراعة القمح في الأراضي حديثة الاستصلاح ٠